REMARKS

Reconsideration of the above-identified application in view of the amendments above and the remarks following is respectfully requested.

Claims 1-16 are in this case. Claims 1-16 have been rejected. Claims 11-13 have now been cancelled.

35 U.S.C. § 102 Rejections – Hall III (US 4,015,366)

The Examiner has rejected claims 1-3, 5, 6, 8-10 and 14-16 under 35 USC § 102 as being anticipated by Hall, III. The Examiner's rejections are respectfully traversed. Claims 11-13 have been cancelled, rendering Examiner's rejection thereof moot.

The Examiner has stated that Hall, III discloses a system for remote monitoring of a filed crop, comprising at least one sensor positionable on a plant of the crop for collecting at least one plant derived parameter; at least one user client for receiving and optionally processing the data; and a communication network.

The present invention is of a remote phytomonitoring system, which employs remote plant-mountable sensors for monitoring plant-derived parameters, in addition to other sensors, in real time, which can be used to determine a state of a crop from a remote location. Applicant is of the strong opinion that Hall, III fails to teach, or imply, use of such plant mountable sensors, or the monitoring of plant-derived parameters, and thus does not, and cannot anticipate the system of the present invention.

Hall, III is titled "Highly Automated Agricultural Production System", and, as recited in the Abstract, comprises the essential components of: 1) A sensing subsystem; 2) A data transmitting subsystem; 3) A computing subsystem; 4) A fluid delivery subsystem, and; 5) A field operations subsystem for harvest, packing, storage and/or maintenance. Thus, the inventor, Arthur D. Hall, III, a well known pioneer in systems engineering theory, sets forth, in very general terms, a plan for a comprehensive, systems approach to the numerous challenges of efficient agriculture. Careful reading of the prior art document reveals that the proposed system (which has never been reduced to practice) is, in essence, an exercise in the application of

sophisticated imaging technology and imaging analysis to agriculture. However, the sensing subsystem of the agricultural system, as taught by Hall, III, is applicable to the monitoring of ambient phenomena, and, contrary to the Examiner's assertion, is not suitable for the monitoring of plant-derived parameters using plant mounted sensors.

The Examiner has stated that Hall, III teaches at least one sensor positionable on a plant of the crop, referring to column 15, lines 34-42 and 61-63 of the cited prior art. The cited paragraphs comprise part of the section entitled "Direct Sensing Means", describing the types of sensors that can be utilized in the prior art invention, and the parameters monitored thereby:

> "Variables particularly amenable to direct sensing in the agricultural system...include percent soil moisture, ground temperature, pH, nitrate/phosphate/potassium ion concentration, and...carbon dioxide concentration. Weather conditions...can be measured by a separate weather sensor package."(column 15, lines 34-42).

Thereafter follows a listing of the types of sensors that can be utilized (column 16, lines 3-54), including a heat sensing soil moisture and ground temperature sensor, a glass electrode for pH measurement, electrodes for measuring humidity, soil potassium and nitrogen content and a photometer for measuring sunlight intensity. Complex means of processing the signals generated by the direct sensing means are disclosed.

The Examiner has stated that the "sensor is capable of being placed on the crop", however, this is, in Applicant's opinion, neither relevant nor consistent with the teachings of Hall, III. Placement of a ground temperature or soil ion content sensor, for example, on a plant of a crop, as asserted by the Examiner, is neither taught nor implied in the prior art document, and, further, such placement would clearly interfere with the accurate functioning of such sensors, which are intended to measure conditions external to the plants.

The Examiner has further asserted that the sensors taught by Hall, III in column 15 are for collecting plant-derived parameters, stating that "nutrient concentration levels in the soil will be determined by withdrawal rate of the plant(s)".

Applicant wishes to point out that this too is incorrect, irrelevant to the issue of plant-mountable sensors for monitoring of plant-derived parameters, and further inconsistent with both the spirit and content of the prior art document.

It is well known in the art that nutrient concentrations in the soil of a crop are commonly heterogeneous throughout any sizeable field, susceptible to broad seasonal fluctuations (see Hall, III, column 15, line 55- 57), and determined by numerous factors including rainfall, irrigation, soil drainage, fertilization, airborne nutrient pollutants, soil fauna (i.e. ameba, worms and insects) and flora (i.e. root-associated microbes), soil particle size and distribution, tillage procedures and interaction between soil nutrients (see, for example, Van Duren et al, Plant and Soil 2000; 220:35-47; Carter, M, pp 130-132, and Simard, et al (abstract, pp 133) in First Atlantic Canada Agricultural Science and Technology Workshop, Truro, Nova Scotia, 1995, enclosed). Clearly, nutrient concentration levels in the soil are determined by much more than the withdrawal rate of the plant(s), and cannot be considered a "plant-derived parameter" useful for determining instantly the state of a plant or a crop.

Thus, it is Applicant's strong opinion that, contrary to the Examiner's assertion, measurement of levels of soil nutrients by the indicated methods of Hall, III, were not intended to, and cannot constitute monitoring of plant-derived parameters, and that one of ordinary skill in the art, attempting to monitor a plant derived parameter for determining the state of a plant or a crop by the soil nutrient assessment methods taught by Hall, III, would not achieve the desired goal with a reasonable expectation of success.

Further, Applicant wishes to point out that the methods described in prior art document, in contrast to the system of present invention, clearly teach the measurement of ambient, environmental parameters, and not plant-related and plant-derived parameters, as taught in the instant specification. For example, in the abstract, Hall, III states:

> "The indirect sensing methods are remote from the area being sensed. The direct and indirect sensing means are adapted to jointly generate data on <u>all important parameters in the homogenous agricultural production area</u>"(abstract); and

> "...which parameters are necessary to achieve desired agricultural product growth" (Claim 1, c).

Thus, according to the prior art document, parameters existing in the agricultural production area, which determine plant or crop behavior, are measured and analyzed. In strong contrast, the plant-derived parameters monitored in the instant invention do not determine plant or crop growth, rather, they are actual manifestations of plant status, such as the stem flux relative rate, stem diameter variation and fruit growth rate taught in the instant specification (see, for example, instant claim 4). These plant-derived parameters can then be characterized and analyzed in relation to environmental parameters similar to the ones measured by the methods of Hall, III, in order to disclose internal plant status, or the state of a crop or plant (see instant claim 2).

Further, the Examiner has stated that Hall, III discloses at least one user client for receiving and optionally processing the data for the at least one sensor to thereby determine a state of the crop. Applicant wishes to point out that according to the methods taught in the prior art document, assessment of the data requires the generation of a "signature", to be compared with known standards:

> "The sensing subsystem of the present invention comprises two essential types of sensors: indirect sensors and direct sensors" (column 14, lines 45-47)" and
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> "The success of indirect sensing depends upon the fact that any particular ground condition will generate...a particular reflection or emission "signature"; this signature can be compared to known standards...to gain an indication what remedial action needs to be taken..."(column 18, line 63, to column 19, line 1).

Highly detailed description of the means for generating the "signature", related to image processing technology, is provided.

It will be appreciated, that in image analysis, the "signature" approach is employed in the event that one cannot interpret an image by using functional analysis, and is in need of comparison with pre-determined templates (standards), in order to generate data.

In stark comparison, the output from the plant-mountable sensors of the present invention may be interpreted using analysis based on empirical models of plant water relationship and growth. Thus, according to the teachings of the present invention, the state of a plant or a crop may be evaluated directly from the data output, without need for further processing, such as generation of "signatures" or "templates".

The Examiner has stated that: "As to claim 2, Hall, III further discloses an additional sensor for soil moisture" (col. 15, lines 34-43). However, careful reading of the cited passage of Hall, III reveals that no "additional sensor for soil moisture" is taught, rather, soil moisture, and other external parameter measurement, as one of the direct sensing means, is primary, rather than additional. In stark contrast, the systems of the present invention specify plant-mountable sensors for monitoring plant derived parameters, with only additional external, environmental sensors recited in dependent claims (see, for example, claim 2).

Thus, it is Applicants strong opinion that the systems approach to agriculture taught by Hall, III does not, and cannot anticipate the systems of remote monitoring, in real time, of plant-derived parameters, according to the teachings of the present invention.

Further, Applicants wish to point out that integral to the remote phytomonitoring system of the present invention is the ability to determine a "state of the crop" or the "state of the plant":

> "Claim 1. A system for remote monitoring of a field grown crop comprising:
> (a) at least one sensor positionable on a plant of the crop, said at least one sensor being for collecting data pertaining to at least one plant derived parameter;
> (b) at least one user client being for receiving and optionally processing said data from said at least one sensor to thereby determine a state of the crop; and
> (c) a communication network for communicating said data from said at least one sensor to said at least one user client."

In strong contrast, the systems approach to agriculture taught by Hall, III is designed to monitor environmental conditions of the soil and atmosphere of a field, but cannot provide information on the state of the crop per se.

Collecting and measuring plant-derived data to thereby determine a state of the crop provides the system of the present invention numerous advantages over the system of environmental monitoring described in the prior art.

Thus, plant-derived parameters, such as "hydration and growth state", as measured by stem diameter variation (page 7, line 25 to page 8, line 8), "water stress or ample watering", as measured by fruit diameter variation (page 8, lines 9-16) or transpiration state, as measured by sap flow (page 8, lines 17-24) which are monitored by the system of the present invention are neither collected nor monitored by prior art systems. Such parameters are crucial for accurate monitoring of plant growth, health state, etc.

It is well known in the art that the growth and development of crop plants, such as fruit trees and flowering plants, requires many component stages, the timing and pace of which depend on the state of the plant with regard to changing environmental conditions. Whereas currently available crop monitoring systems depend on statistical crop performance data accumulated from past experience, and applied in a predetermined manner over the crop's cultivation cycle in response to perceived changes in environmental conditions, the present invention facilitates real-time monitoring of the state of the crop, relying on plant-derived, rather than environmental data for precise and accurate crop management.

The state of the crop "...which can be a disease state, growth state, hydration state and the like..." can be determined by "data processing" from the plant mounted sensors or by "simply comparing sensor data collected over a period of time."(page 7, lines 25-30). Furthermore, accumulation and processing of data collected by the remote sensors can provide unique long term crop characteristics previously unavailable to growers, such as daily integration of solar radiation, reference evapotranspiration, etc., as well as duration and magnitude of measurable stress conditions. By carefully selecting individual plants as crop standards (page 11, lines 25-31), and by providing remote and/or automated processing, transmission and storage of the data collected by the remote plant mountable sensors, the system and

method of the instant invention enable a remote operator and/or data processing system to track and monitor the state of the crop, and, if necessary to effect changes in horticultural parameters as required. Thus, the present invention provides a grower with the tools to monitor crop and plant state and respond to changes in plant growth parameters with superior precision and speed, achieving improved crop yield, quality and resource (water, energy, etc.) conservation with reduced investment.

In stark contrast, Hall, III discloses: "...a computer controlled agricultural system which...enables one to automatically perform all major agriculture production system activities..." (column 11, lines 12-15), based on monitoring by "direct sensors" of soil moisture, ground temperature, pH, soil mineral content, and carbon dioxide concentrations, and by "indirect", remote-mounted sensors of radiation of various wavelengths.

Notwithstanding the above arguments, Applicant wishes to point out with respect to claim 3, that none of the sensors listed in claim 3 are anticipated nor are these sensors rendered obvious by the teachings of Hall, III, all being plant mounted sensors of plant derived parameters determining the state of a crop.

Thus, Applicant is of the strong opinion that Hall, III does not describe, nor does he suggest systems or methods suitable for remote and precision monitoring of individual plants, or numbers of plants, by plant mounted or plant mountable sensors of plant derived parameters, and processing of the data obtained thereby for determining the state of a crop, as provided by the system of the instant invention, and as such, cannot, and does not anticipate the remote phytomonitoring system of the present invention.

35 U.S.C. § 103(a) Rejections – Hall, III (US Patent No. 4,015,366) in view of Takayama et al. (JP59038655 A) and McNabb et al. (US Patent No. 5,884,224)

The Examiner has rejected claims 4 and 7 under 35 USC § 103(a) as being unpatentable over Hall, III in view of Takayama et al on the basis of obviousness, and claims 11-13 under 35 USC § 103(a) as being unpatentable over Hall, III in view of McNabb et al. on the basis of obviousness. The Examiner's rejections are respectfully traversed. Claims 11-13 have been cancelled, rendering Examiner's rejection thereof moot.

The present invention is of a phytomonitoring system employing remote, plant-mountable sensors for sensing plant-derived parameters, which can be used to determine a state of a crop from a remote location.

Applicant is of the opinion that Hall, III does not, neither alone, nor in combination with the teachings of Takayama et al, teach or provide motivation for the use of a system for remote monitoring of a crop from plant-derived data.

In regard to claim 4, the Examiner has stated that Hall, III discloses at least one additional environmental sensor and a plant mounted sensor, and that Takayama et al discloses a plant-mounted CO_2 detector, thereby rendering the system of claim 4 obvious.

Applicant wishes to point out that the systems approach to agriculture taught by Hall, III defines the two types of data on which the function of the system is based as direct and indirect, and that both types of sensing subsystems are considered essential to the operation of the prior art invention (column 14, lines 45-47). Despite the highly detailed description and Figures provided, no mention of monitoring plant-derived parameters using plant-mountable sensors is made or inferred throughout Hall, III. For example, Figures 2 and 15 illustrate the placement and use of direct sensors, however, no indication of a plant-mounted sensor is made. As detailed hereinabove, the specification does not provide any further direction for collecting and/or monitoring plant-derived parameters.

Figures 3, 4 and 5 further illustrate the use of indirect sensors for collection of data. Obvious in these Figures, and in other related portions of the specification, is the nature of the data being collected, i.e. images based on emission of radiation and sensed at a considerable distance from the source.

Two examples of the operation of the system as described by Hall, III further emphasize the absence of "plant-derived" parameters from the decision-making basis of the prior art system. In describing the operation of the fluid delivery subsystem, Hall, III details the means by which "deficiencies" in the soil ion content are sensed by direct sensors, and corrected by fluid delivery system (column 44, lines 47-62). Soil moisture sensors similarly signal deployment of irrigation via the fluid delivery subsystem (column 46, lines 37-63). Conspicuously absent in all examples, and Figures, is the monitoring of a plant-derived parameter, to provide a measurement of

the state of the plant or crop, to be used in determining which remedial steps need to be taken, and to what extent.

Thus, one cannot escape the conclusion that Hall, III fails to teach the use of plant-mounted sensors for monitoring plant-derived phenomena in order to determine the state of a crop or plant.

As such, it is Applicants strong opinion that one of ordinary skill would not be motivated to modify the system of Hall, III by adding the plant mounted carbon dioxide detector disclosed by Takayama et al. so as to ensure optimum plant growth. Indeed, no provisions for the integration of such plant-derived data are described, and it is unclear how the user client would make use of the data.

Further, instant claim 4 teaches the remote phytomonitoring system of the present invention comprising at least one plant-mountable sensor for monitoring a plant-derived parameter (claim 1), with the added limitation of at least one additional environmental sensor (claim 2) and wherein the at least one additional sensor includes at least one environmental sensor and at least one plant-mounted sensor. As described above, Hall, III fails to disclose any plant-mounted sensors for monitoring plant-derived parameters; thus, one of ordinary skill in the art would not be motivated to add environmental and plant mounted sensors, as disclosed by Takayama et al., to the direct or indirect sensing means disclosed by Hall, III.

Further, Applicant wishes to point out that Takayama et al discloses a plant physiology measuring apparatus having a measuring container for measuring photosynthesis on a portion of a leaf by monitoring the absorbed CO_2. No mention is made of remote monitoring of any of the data gathered by the measuring container, nor is the application of such data to determine the "state of a crop" mentioned or implied. Further, as illustrated (Figs. 1 and 2, pages 282-83), the restrictive measuring container disclosed by Takayama et al. is wholly unsuited for remote phytomonitoring, in that there is no provision for growth of the leaf being measured throughout the growth cycle of the plant/crop being monitored.

Thus, one of ordinary skill in the art, in possession of the teachings of Takayama et al., would not be motivated to combine the measuring container of Takayama et al. with the system as disclosed by Hall, III, to ensure optimum plant growth. Yet further, in the event that such a combination were to be made, it would

not achieve the goals (remote monitoring of a crop) with a reasonable expectation of success, due to the limitations noted hereinabove.

In view of the above remarks it is respectfully submitted that independent claim 1, and claims 2-10 and 14-16, which directly or indirectly depend therefrom are now in condition for allowance. Prompt notice of allowance is respectfully and earnestly solicited.

Respectfully submitted,

Sol Sheinbein
Registration No. 25,457

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Encl.:
Two months extension fees; and
Cited references:
Carter
Simard, et al. (Abstract)